The Soil Sentinel

The Soil Sentinel MARCH 2023

INSIDE THIS ISSUE:

Healthy Soils for a Green Future Event, Edinburgh: Engagement is key!

Kenneth Loades (The James Hutton Institute) and Paul Hargreaves (SRUC)

March 2023 signifies the end of the first year for the Healthy Soils for a Green Future project funded through Scottish Government. There has been much work in the first 12 months of the projects and in this edition of The Soil Sentinel you can see some of this work within the poster summaries, and talk abstracts, provided. Each complete poster can also be viewed on our Zenodo Healthy Soils community accessible here: **https://bit.ly/3nyZltV!**

The project team were keen to highlight some of the initial findings, and future plans at the first of our annual project workshop which was held in the austere rooms of the Royal Society of Edinburgh. The event was well attended by over 50 people from researchers and science advisors to those working on Scottish Government policy, regulators, and other key stakeholders.

The day was opened by the coordinator of the Healthy Soils project, Dr Roy Neilson, who outlined the research areas and looked to the near future and the possible effects of the European Soil Mission and the Soil Health Law that would specify a legally-binding framework for harmonised soil target setting, monitoring, and reporting and how this could impact on Scottish soils work.

Professor Mathew Williams, Chief Scientific Adviser (CSA) Environment, Natural Resources and Agriculture for Scotland, highlighted the importance of soils in tackling many critical issues facing us today, the biodiversity crisis, climate crisis and the need for resilient landscapes. His message was clear of the need for robust data from good science. Without this evidence, robust policies and solutions to the challenges we are facing will be impacted with soils critically important in delivering to Scotland's environmental goals. It was also noted that policy needs to be adaptive in response to scientific understanding. Resilient soils will provide a more resilient Scotland to the future challenges we are likely to face.

The first two presentations outlined the focus of the day, the need to understand soils from both a functional and provisioning services perspective. Critical is the development

of an effective monitoring scheme and also indicators of change. One of the main methods of measuring the health of the soil is by using the correct and valid soil indicator with Dr Nikki Baggaley from the James Hutton Institute outlining work in this area to date.

It was great to hear from NatureScot and SEPA, both organisations who have significant interest in the outcomes of the Healthy Soil program. Dr Karen Dobbie from SEPA spoke of the value of our research and also the desire to work together further in addressing key issues and the need for stronger evidence of the multiple benefits of sustainable soil use and management. Dr Clive Mitchell from NatureScot echoed these thoughts including the need to effectively translate core science into policy and management outputs. Effective engagement is central to this and one which we hope to continue to develop as the project, and findings, develop further.

During the second session there was a summary of the research platforms used in the project by Dr Christine Watson and you can find more about these in the article on page 5 which includes a map and QR codes linking to more detailed information on each site. This was followed by Dr Paul Hargreaves from SRUC who summarised the knowledge exchange activities and also the significant engagement achieved through support from the SEFARI Gateway in attending the World Congress of Soils Science. You can see information generated for this on the Scottish Soils website accessible here: **https://bit.ly/3Ztizy8**.

Drs Jagadeesh Yeluripati and Maddy Giles ended the session with talks on modelling soil carbon and also work in managing nitrous oxide emissions from soils. Specifically Jagadeesh spoke about the potential for sensor network technologies contributing to the predictions of GHG emissions, soil carbon change, crop yields and N leaching. Maddy meanwhile highlighted the opportunities in the use of low GHG emitting plant varieties and the role of the soil microbiome in determining CO_2 emissions from soils.

After lunch the final session included talks from other soils projects funded by Scottish Government which link to the

Healthy Soils project. Dr Mark Wilkinson outlined work on nature based solutions (NBS) to future water-related environmental pressures and in understanding the restoration benefits for climate resilient river corridors. Mark highlighted how NBS can deliver multiple benefits, such as safeguarding biodiversity, in addition to those associated with managing flooding and C sequestration.

Dr Rebekka Artz followed this with an update on the CentrePeat project, an essential part of the Scottish Government funded work on peatland for both sustaining and enhancing peatland in Scotland, this has previously featured in The Soil Sentinel.

Other speakers considered the wider soils environment with talks on the future land capability for Scotland by Emmanuel Udugbezi and a talk from Professor Bob Rees on soil carbon sequestration and achieving Net Zero by 2045 related to land-use. Finally, Alistair McVittie considered the value of the natural capital of Scotland's landscapes.

The day ended with an open discussion on the theme of knowledge exchange and how such events can be improved. It was noted that, more than ever, we need to continue to engage and ensure the correct message is made available to the right people at the right time.

POSTER Measuring soil properties with your phone - Hybrid Digital Soil Mapping and image analysis (https://bit.ly/3nyTYeI)

Matt Aitkenhead (The James Hutton Institute) and Adnan Khan (The James Hutton Institute and Abertay University)

Measuring soil properties is important for multiple reasons; there are multiple land uses and industries that rely on soil information such as carbon content, structure, pH, texture or density. However, soil analysis in the laboratory is often time-consuming and expensive.

We have been exploring the possibility of using mobile phone images as a fast and low-cost alternative to laboratory-based 'wet chemistry'. Using the Conditioned Latin Hypercube (CLH) sampling strategy method, we identified sample locations at Finzean Estate that provided representative information for Digital Soil Mapping (DSM) and phone-based monitoring of soil properties. A database of imagery and topsoil sample properties has been developed and investigated for its potential to allow rapid assessment of use to land managers.

The Conditioned Latin Hypercube (CLH) approach was successfully applied to a stack of spatial datasets extracted for the Finzean Estate in Deeside, allowing 50 sample locations to be identified.

Analysis of the extracted points showed that the variability in spatial datasets is

appropriately captured by these points.

Laboratory analysis of the topsoil samples is ongoing, with several of the properties (C, LOI, pH, bulk density) already determined.

Work is ongoing to develop an image analysis approach for extracting meaningful image characteristics that can be linked to soil properties alongside the spatial covariate values.

An expanded field campaign with more samples across Scotland is planned for 2023/24.

For more information contact Matt Aitkenhead Matt.Aitkenhead@hutton.ac.uk

POSTER Soil multifunctional resilience: The influence of agricultural practice on soil microbiome functioning (https://bit.ly/3ITnGtT)

Fiona Fraser, Christine Watson and Nicola Holden (SRUC)

Soil functions underpin essential ecosystem functions (food security, water purification, carbon storage etc.) In turn, soil functions are determined by the soil microbial community whose abilities are moderated by the abiotic environment.

Here, the Healthy Soils programme aims to refine our understanding of the functional processes from the microbial communities present in soil, the interactions with parameters commonly altered due to agricultural practice and how this influences the resilience of these functions to exogenous stress events.

Here we used temperature stresses (freezing and heating) to probe the resilience of the microbiomes metabolism under long-term (100 years) differing agricultural management.

Resilience - the ability to recover to functional levels similar to that of control (or undisturbed) samples after disturbance.

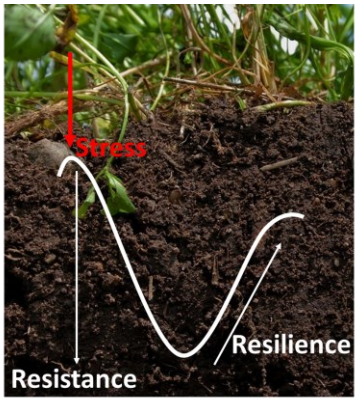
Cold shocked samples generally less resilient. Less consistency across fertiliser regimes – conventional management (NPK) shows greatest difference between shock treatments (Figure 1).

Resistance - the ability to maintain functional levels similar to control (or undisturbed) samples in the face of disturbance. The resistance appears most variable in the cold shocked samples.

Generally lower and more variable in cold shocked samples, this is consistent across fertiliser regimes

Next steps: This work will lead directly into similar testing in year 2 across a range of pH treatments, this testing will be paired with DNA sequence analyses and carbon stock data for the same soils to increase our understanding of how management differences paired with inherent soil characteristics and communities integrate to produce soil health outcomes. This knowledge will be used to aid guidance on using the principles of soil health for agricultural management.

For more information contact Fiona Fraser: Fiona.Fraser@sruc.ac.uk

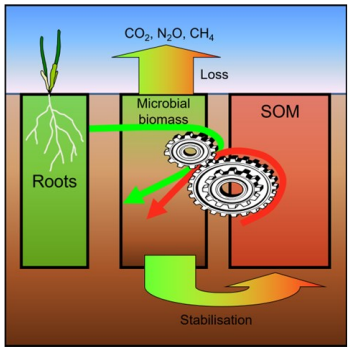


POSTER Biological processes underpinning soil ecosystem services (https://bit.ly/3TV3FzE)

Eric Paterson and Clare Cameron (The James Hutton Institute)

Soil is a fundamental resource supporting delivery of ecosystem services underpinning societal, environmental and economic benefits. Historically, these benefits have been linked closely to soils' capacity to sustainably support plant primary production for food, fibre, and fuel, thereby supporting human life and activities.

These provisioning services remain vital, particularly in the context of increasing global populations, a changing climate and competing pressures on land use. However, a host of other services that soils provide are now recognised to underpin environmental and cultural services that need to be considered in management and policy decisions relating to soils and land use.



The soils of Scotland are highly diverse, shaped by climate and their underlying geology, meaning that the ecosystem services that they can potentially support is variable.

Management of soils for single ecosystem services (e.g., greenhouse gas mitigation) has consequences for others (e.g., food production), and understanding these potential trade-offs, across diverse soils, is a focus of this research.

The desk review of existing knowledge on soil ecosystem services identified successful use of soil properties to predict services that are primarily controlled by physico chemical processes (e.g., resistance to erosion, water infiltration), but that prediction of biologically driven functions (e.g., greenhouse gas fluxes, nutrient cycling), is more difficult, particularly in the context of dynamic changes associated with management practices.

The soil functional analyses identified strong soil type effects on biological processes, and that for a single soil, management has a significant impact on the capacity of that soil to mediate processes underpinning greenhouse gas fluxes, element cycling, plant productivity and nutrient retention.

For more information contact Eric Paterson: Eric.Paterson@hutton.ac.uk

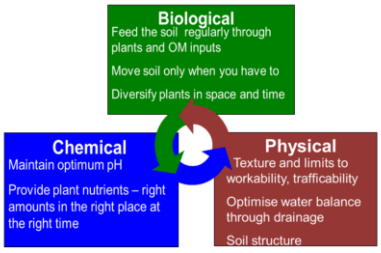
POSTER Soil Health Indicators for Scotland: Are Soil Health Indicators reflecting the situation in Scotland and are they working? (https://bit.ly/3lUSlqO)

Paul R. Hargreaves, Rosie Boyko, Christine Watson (SRUC)

Any monitoring or management of soils needs to incorporate the understanding of the chemical, physical and biological process that combine together to produce a healthy soil.

Work with the AHDB GreatSoil partnership suggested a list of soil health indicators based on expert knowledge for English, Welsh and Scottish soils. However, as Scottish soils are different both physically and their underlying chemistry, there is a need to investigate the soil health indicators using referenced research papers for similar conditions to Scotland.

Once a specific list of soil health indicators had been identified these were compared with the AHDB suggested indicators. Additionally, the methodology for assessment of soils health criteria as good, moderate and poor for actual Scottish soils needed to be assessed. This began with the most commonly used criteria and reflected the end user interests to encourage uptake



Similar assessments for soil health were recognised with two different ranking systems. Focus on SOM or soil C has become much greater in recent years, especially with the interest as a mitigation measure for climate change. Longer-term grass lays (over 5 years) with would be expected to return results as good but only gave moderate results. Certain upland soils had very wide bands, especially for good, with high upper limits for SOM (96% to 80%) and may not reflect the average values expected across an area.

For more information contact Paul Hargreaves: Paul.Hargreaves@sruc.ac.uk

POSTER Interaction of climate and soil pH in determining crop resilience and quality (https://bit.ly/3zfPzzx)

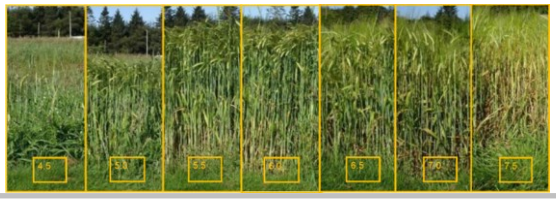
Kairsty Topp, Robin Walker, Rob Graham, Andrew Mead and Christine Watson (SRUC)

The impacts of climate change on yields and crop quality are moderated by land management practices.

Soil pH plays a crucial role in nutrient cycling with maintenance of soil at the optimum pH critical for maximizing yield. For example, Spring barley was seen not to tolerate low pH however was tolerant of high pH. Conversely Spring oats was found to be tolerant of low pH but not high pH. Utiising trial data we predicted the asymtopic maximum yield based on these observed relationships.

Findings showed that Asymptotic maximum yield was impacted by weather, pH was found to impact grain N% with grain N yield impacted by both pH and weather.

For more information contact Kairsty Topp: Kairsty.Topp@sruc.ac.uk

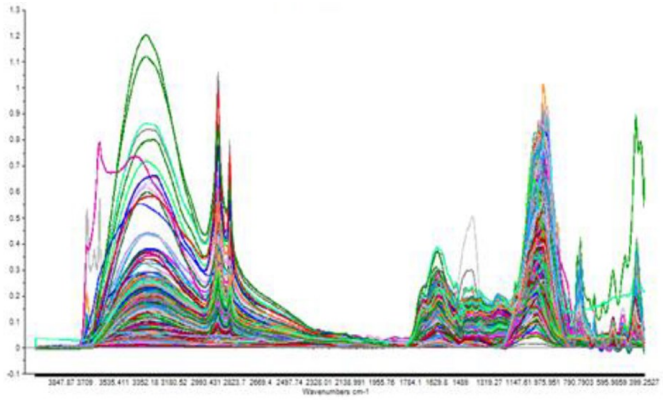


POSTER FTIR: A Novel Method for Assessment of Soil Health Fourier Transform Infrared (FTIR) Spectroscopic Analysis in the Assessment of Soil Health and for Improved soil monitoring (https://bit.ly/40vGRJw)

Jean Robertson, Angela Main, Reza Haghi (The James Hutton Institute)

The amounts and quality of soil organic- and mineral-matter affects soil health. They influence properties including water holding capacity and the supply of nutrients. An FTIR spectrum gives the overall chemical profile of the soil. Importantly an FTIR spectrum provides information about both the organic and inorganic components. FTIR spectroscopy has the potential to provide information about the amounts and quality of soil organic matter (SOM), clays and other soil minerals. Therefore, information derived from the FTIR spectra of soils can be linked to soil health. Multiple soil properties can be predicted from a single FTIR spectrum (e.g %C, %N, moisture, bulk density). This also makes FTIR an effective method for rapid and economical monitoring of soil.

FTIR has been shown to give accurate predictions of soil health indicators such as soil organic carbon, soil moisture and bulk density from a single scan. Model development will allow prediction of new soil health indicators by FTIR such as PLFAs (which relate to the microbial community) and (a proxy for rate of decomposition of organic matter). Novel handheld FTIR methods are being developed to allow 'in field' soil health assessment on a spatial and temporal scale not previously possible. This research is contributing to the F.A.O. GLOSOLAN global initiative to help countries use soil spectroscopy to understand soil conditions, improve agricultural productivity and reverse land degradation.

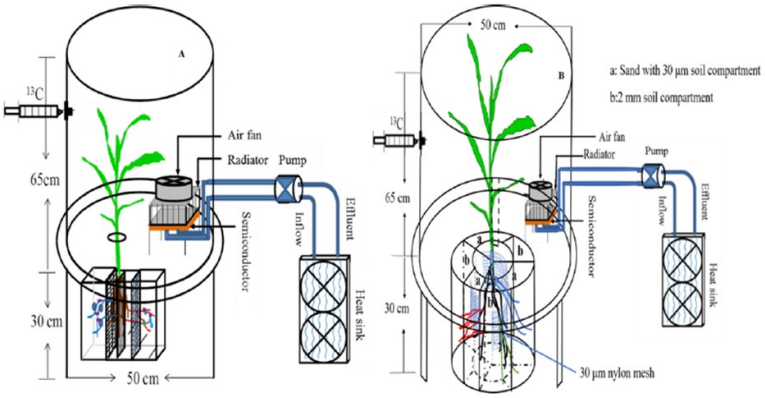


For more information contact Jean Robertson: Jean.Robertson@hutton.ac.uk

POSTER Trophic interactions enhancing soil P. Arbuscular mycorrhizal fungi have a greater role than root hairs for selecting a microbiome and enhancing rhizosphere organic P mineralization (https://bit.ly/3KjygUt)

Timothy S George, Lawrie K. Brown, Susan Mitchell, Jiachao Zhou, Lin Zhang, Gu Feng (The James Hutton Institute)

Root hairs, arbuscular mycorrhizal (AM) fungi and rhizosphere microbiome all play important roles in mycorrhizal plant phosphorus (P) absorption from soil. However, how the plant AM fungi rhizosphere microbiome continuum interacts to promote the use of soil P is still unclear. Here, we present results of a controlled environment experiment to reveal the effect of root hair, AM fungi and their interaction on rhizosphere microbial Po cycles. Compared to root hairs, AM fungi contributed more to active microbial community assembly, functional gene recruitment and Po mineralization. The rhizosphere microbial Po mineralizing process contributed more than half of plant P assimilation in the P limited condition. The application of inorganic P (Pi) reduced the effect of root hairs and AM fungi on rhizosphere microbial community assembly and Po mineralizing ability. Our findings demonstrate the importance of AM fungi for short root hair crop species as a driving force for rhizosphere microbial recruitment and function.



We conclude that while root hairs are important in species which have a long root hair system, in maize with a short root hair system AMF are functionally superior. There are interactions between AM fungi and root hairs not only due to morphology, but also due to differential shifts in rhizosphere microbial diversity and function. In low Pi conditions, AM fungi and root hairs both influenced the rhizosphere microbial numbers and community assembly. Importantly, AM fungi had a greater impact on microbial structure and function than root hairs and played a more important role in recruiting bacteria that could release phosphatase and improve the utilization of organic P. The organic P mineralization process is driven by the rhizosphere microbiome and contributed more than half of plant P assimilation. In high Pi conditions, the effects of AM fungi and root hairs on rhizosphere microbiome assembly and function almost disappeared.

For more information contact Tim George: Tim.George@hutton.ac.uk

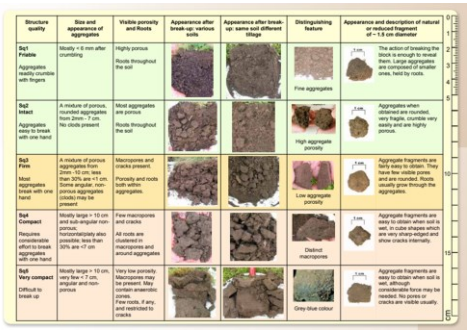
POSTER Soil health and function: Physical characteristics, function, and soil health status of compost amended soil

(https://bit.ly/3lQM3sj)

Kenneth Loades, David Boldrin, Mark Hanlon and Anna Taylor (The James Hutton Institute)

Soil physical structure underpins different soil functions. These functions are critical with significant spatial contributions, from field to the catchment, and the wider environment. Examples of such functions include flood mitigation, reducing soil erosion, and influencing greenhouse gas emissions from soil. Sustainable management of agricultural soils aims to optimise soil physical condition ensuring that soil functions are maintained. The application of indicators to characterise soil health is key in both top and sub-soils to monitor and assess soil ecosystem services.

There are a number of tools to characterise soil structure (e.g., aggregates) such as the Visual Evaluation of Soil Structure (VESS) and the slake test. These are reported to work well under typical conditions. However, questions must be asked on their efficacy under different soil management regimes. Furthermore, it is important to understand how these indicators link to soil physical functions such as water holding capacity, hydraulic conductivity, plant available water, and soil resilience to



In top-soils plant available water and water stable aggregates (WSA) was shown to increase significantly with increasing compost application rates (similar to that observed with Dexter S). Hydraulic conductivity in top-soil was found to be higher in plots with the highest rates of compost application. Sub-soil hydraulic conductivity in moderately applied compost plots was significantly higher than in control plots. Even under minimum tillage conditions changes, significant changes in sub-soil function were observe with compost application. No link observed between organic carbon in subsoils and bulk density.

For more information contact Kenneth Loades: Kenneth.Loades@hutton.ac.uk

POSTER Microbial community composition can drive differences in CO2 emissions from soils planted with different grass varieties

(https://bit.ly/3nyUfOp)

Maddy Giles, Sandra Caul, Dale King, Susan Mitchell and Eric Paterson (The James Hutton Institute)

Plant-soil interactions play an important role in regulating CO2 emissions and storage of carbon (C) as soil organic matter (SOM) creating the potential for crop selection to be a tool for sustainable agriculture. This is of particular importance in grassland soils which are known to be important stores of C. However, there is still a need to understand whether the selection of different grass species and varieties can control the rates and products of C cycling and if this is driven by the interaction with below ground microbial communities.

Microbial communities are central to the regulation of soil functions that mediate processes such as C cycling. Consequently, soil communities influence greenhouse gas (GHG) emissions, soil C storage and nutrient availability by regulating the biogeochemical processes that determine the fate of C in soils. Understanding the structure and function of soil communities associated with plant roots is therefore critical to understanding how crop selection can help soils be managed for multiple benefits.

The aims of this study were therefore to characterise plant-driven soil microbial community selection across a range of agricultural grasses, and to assess the extent to which distinct microbial community compositions were predictive of CO2 emissions from soil.

Conclusions

- The selection of grass variety for cultivation has the potential to be an important tool for managing soil C storage and CO2 emissions in grassland soils.
- Different grasses selected for their own unique microbial communities and the composition of these communities had a small but significant effect on CO2 emissions from soils.
- This provides insight into the potential mechanisms by which grass selection may control the partitioning of C into soil, plant and atmospheric pools.

For more information contact Maddy Giles: Maddy.Giles@hutton.ac.uk

POSTER Rise of the pHoenix: relocation of a 60+ year old soil pH gradient experiment (https://bit.ly/40reyvF)

Robin Walker, Kairsty Topp, Rob Graham and Christine Watson (SRUC)

The Woodland's Field pH long-term-experiment (LTE) was started in 1961 and comprised an 8 course rotation, with every crop grown every year. A soil pH gradient was superimposed across all crops, with target soil pH ranging from pH4.5 to pH7.5, with plots maintained at 0.5pH increments giving 7 pH treatments in total. The rotation consisted of 3 years grass and white clover followed by winter wheat, potatoes, spring barley, swedes with undersown spring oats.

Soils from the original Woodland's Field pH LTE were removed to a depth of 20cm, starting with those from the pH4.5 treatments. These

were mixed in the trailers prior to relocation into pre-prepared 4m x 5.5m holes, also excavated to a depth of 20cm, at the new pHoenix site. The new site only ever had holes excavated for 2 of the target soil pH treatments at any one time in order to reduce the risk of soils being deposited in the wrong location. Once the pH4.5 soils had been relocated to their new "home", the pH5.5 plots were marked out ready for excavation, and the pH5.0 plots were relocated to their pre-excavated positions. The pHoenix LTE was sown out to ryegrass immediately after the move to allow the plots to settle, and pH modifications were started once the first routine soil pH analysis was made on each plot – this has been done twice per year; the new rotations and management on the pHoenix LTE will commence in spring 2023. As well as the 5 and 7 course rotations which will have 3 phases from each present in any one year, there will be permanent beds of ryegrass and a multi-species grassland. Each crop will receive fertilizer, herbicide and fungicide inputs at rates typical for the region.

For more information contact Robin Walker: Robin.Walker@sruc.ac.uk

POSTER Disease suppressive soils: Can integrated soil management result in disease suppression through the creation of healthy soil microbiomes (https://bit.ly/3K420Ua)

Jennie Brierley, Eva Randall, James Lynott, Louise Sullivan, Sue Jones and Tung On Yau (The James Hutton Institute)

The Centre for Sustainable Cropping (CSC) was established at Balruddery Farm (NE Scotland) to integrate all aspects of sustainability research on arable ecosystems at The James Hutton Institute. This included the establishment of a six-field rotation. Each field in the rotation is split into two halves. One half is managed according to current conventional crop husbandry practice and one half has an evolving integrated management package. The goals of the integrated management strategy are to: i) Enhance microbial, plant and invertebrate biodiversity for ecosystem services, ii) Reduce reliance on mineral fertiliser and increase resource use efficiency, iii) Improve soil structure. A preliminary experiment comparing disease severity on potato grown in the two differently managed soils, after being challenged with the potato pathogen Rhizoctonia solani AG3, indicated that soil from the integrated treatment had disease suppressive properties. In the current SRP, we are building on this data to determine: whether integrated soil management can result in disease suppression through the creation of a diverse and healthy soil microbiome. If legacy effects of integrated management in the non-potato crops remain beneficial in terms of reducing disease in a potato crop. If potato cultivation reduces soil microbial diversity, how quickly does it re-establish post potato cultivation.

Here, we describe preliminary results comparing the soil microbiomes of the conventional and integrated management treatments in March pre-potato cultivation and July post-planting of potato.

Following 5 years of integrated soil management, in March – pre planting of potato, the soil microbiome was more diverse than (Shannon index of alpha diversity) and distinctly different to (Beta diversity) the microbiome of the soil which had been managed conventionally. Planting of potato reduced the alpha diversity of the microbiome in the soil under integrated management, and it was no longer distinct from that of the conventionally managed soil. We have not yet demonstrated that the integrated management strategy consistently results in disease suppression in all fields across the rotation.

For more information contact Jennie Brierley: Jennie.Brierley@hutton.ac.uk

POSTER Variety-tillage interactions: Identifying varieties and their traits for adaptation to soil conditions: tillage adaptation (plough/no-till) (https://bit.ly/3IWiRjB)

Adrian C Newton and Tracy Valentine (The James Hutton Institute)

Cereal and other crop varieties are bred for optimum performance under high input conditions, particularly fertilisers, pesticides and tillage. **With increasing trends towards lower inputs and reduced soil tillage for enhanced sustainability, do we have the appropriate varieties?**

Reduced inversion tillage is an important trend for improving soil health and an essential component of 'regenerative agriculture'. Anecdotal evidence suggests that, as with organic agriculture, certain varieties are better adapted to non-inversion tillage.

We are identifying such varieties, characterizing their adaptation and trying to identify the traits that are responsible. Root traits are likely to be particularly important and we know that cultivation causes a big shift in soil microbial populations.

Varieties change ranking in response to differences between soils caused by tillage

Varieties may be preferentially-adapted to non-inversion tillage, inversion tillage or both

Non-inversion tillage cereal crops can be more resistant to rusts and powdery mildews

Crop (rotation) history and other environmental factors can affect yield ranking also

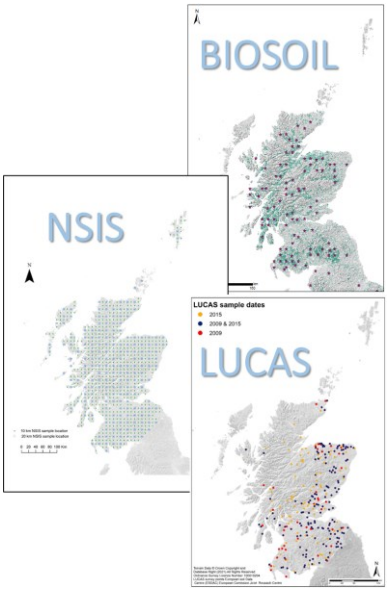
Detailed characterization of changes in soil and effects on crop growth are needed to identify key response traits.

For more information contact Adrian Netwon: Adrian.Newton@hutton.ac.uk

TALK ABSTRACT Soil Monitoring Framework and Indicators

Nikki Baggaley (The James Hutton Institute)

There is an international drive for the development of a soil monitoring frameworks with many research questions around how data from different sampling campaigns can be integrated to provide a robust picture of soil health. Critically it is important for the framework to also record changes in soil health at different scales.



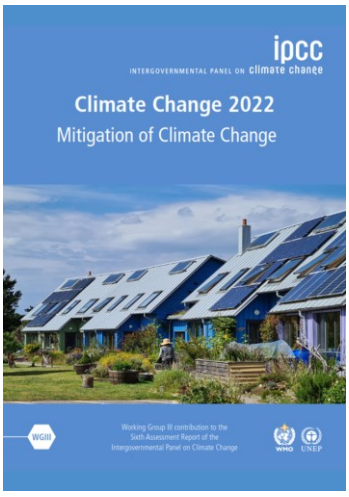
Part of the work on developing a soil monitoring framework and indicators has been to review existing data sets alongside both national and sector specific data from Scotland. Such datasets could form the basis of assessing change in Scotland's soils. The presentation will summarise work into methods for rapid sampling, analysis of data on soil carbon decomposition, and compiling, and analysing, data sets of soil physical measurements, carbon stocks, and erosion observations..

For more information contact Nikki Baggaley: Nikki.Baggaley@hutton.ac.uk

TALK ABSTRACT Developing Near-Real Time Soil Carbon Sequestration and GHG Predictions: Step Toward NetZero

Jagadeesh Yeluripati (The James Hutton Institute)

Across Scotland there is a unique range of experimental platforms where we can test and demonstrate the impacts of different land management techniques on soil health and function. Within Healthy Soils for a Green Future project we focus on 4 main research platforms located in the East of Scotland. The Centre for Sustainable Cropping and Grieves Farm near Dundee provide arable facilities with a range of cropping systems and tillage types. Glensaugh Climate-Positive Farm, near Fettercairn, provides pasture-based systems and agroforestry, and the ACE Platform at Craibstone, near Aberdeen, is the home to long-term field experiments on soil pH and legume supported farming systems. This presentation will explore these facilities and what they offer to the RESAS Strategic Research Programme and other funding initiatives.

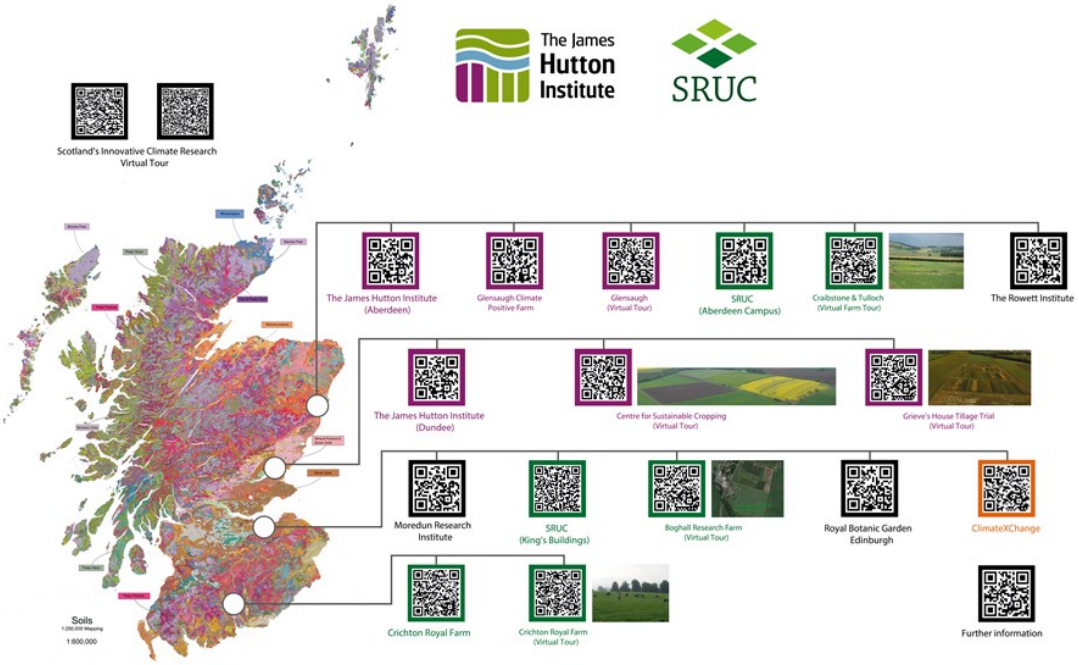


For more information contact Jagadeesh Yeluripati : Jagadeesh.Yeluripati @hutton.ac.uk

TALK ABSTRACT Healthy Soils research platforms

Christine Watson (SRUC)

Across Scotland there is a unique range of experimental platforms where we can test and demonstrate the impacts of different land management techniques on soil health and function. Within Healthy Soils for a Green Future project we focus on 4 main research platforms located in the East of Scotland. The Centre for Sustainable Cropping and Grieves Farm near Dundee provide arable facilities with a range of cropping systems and tillage types. Glensaugh Climate-Positive Farm, near Fettercairn, provides pasture-based systems and agroforestry, and the ACE Platform at Craibstone, near Aberdeen, is the home to long-term field experiments on soil pH and legume supported farming systems. This presentation will explore these facilities and what they offer to the RESAS Strategic Research Programme and other funding initiatives.



For more information contact Christine Watson: Christine.Watson@sruc.ac.uk

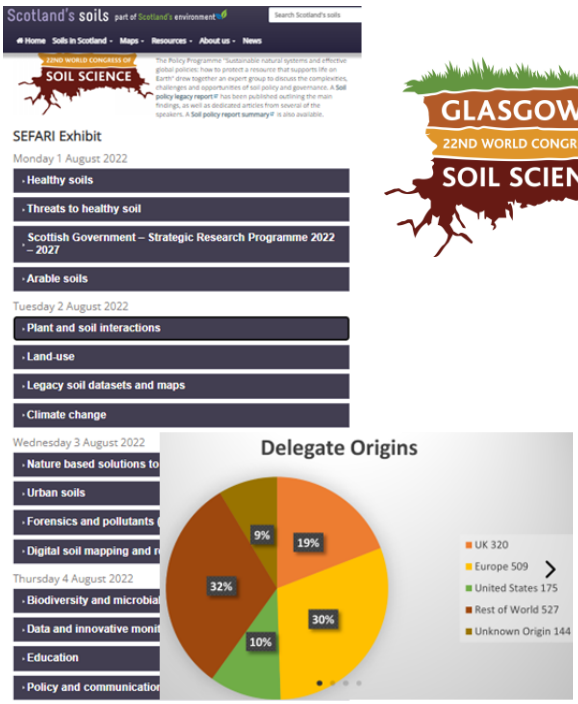
TALK ABSTRACT Knowledge exchange and engagement

Paul Hargreaves (SRUC)

Key to maximising the impact and adoption of research outputs is effective delivery and engagement with stakeholders both within Scotland, the UK, and the wider global scientific community. Outputs developed within the Healthy Soils project funded through Scottish Government and the strategic research programme have been delivered at a number of events over the year with a newsletter, The Soil Sentinel launched at the Royal Highland Show in 2022, highlighting research within Healthy Soils and other soils related outputs from the wider strategic programme. The Soil Sentinel in now in its third edition and has covered issues from peatland restoration to biota of the soil.

In the first 12 months of Healthy Soils the project has been associated with 33 publications and recorded 97 engagement activities to date. Engagement activities have included a presence at The Royal Highland Show, Arable Scotland, and at the World Congress of Soil Science (WCSS) which took place in Scotland providing a fantastic opportunity to showcase our world leading research to a global audience. Attendance at the WCSS was supported through funding secured from the Scottish Environment Food and Agricultural Research Institutions (SEFARI) Gateway.

For more information contact Paul Hargreaves: Paul.Hargreaves@sruc.ac.uk or Kenneth Loades: Kenneth.Loades@hutton.ac.uk.



TALK ABSTRACT How do we understand the impact of management on soil function?

Maddy Giles (The James Hutton Institute)

Plant-soil interactions are fundamental for regulating nutrient cycling in soils, and the management of these interactions represent a potential means to regulate CO_2 and N_2O emissions, nutrient retention and storage of C as soil organic matter (SOM).

Understanding the role of plant soil interactions in controlling nutrient cycling requires both the ability to quantify the function of interest and clarify the mechanisms controlling it, including understanding the ecology of the soil microbiome which underpins many nutrient cycling processes. This makes it possible to identify whether management strategies such as crop selection targeting beneficial plant-soil interactions may be a tool for sustainable agriculture and maintenance of soil health. This may be of particularly relevance in grassland systems which are important stores of C. Here we used both controlled environment experiments and field trials to explore the relationship between, different grass species, the soil microbiome and the emissions of CO_2 and N_2O from soil.

For more information contact Maddy Giles: Maddy.Giles@hutton.ac.uk

TALK ABSTRACT Achieving Multi-Purpose Nature-Based Solutions (AiM NBS)

Mark Wilkinson (The James Hutton Institute)

Nature Based Solutions (NBS) have been identified as one solution to many water related environmental pressures. However, scientific evidence and guidance are needed to support implementation. Coupled with this, greater focus must be given so that these solutions can provide many more ecosystem services and there are potentially ways to maximise these benefits further in managed landscapes.

This project aims to: a) Develop a multi-scale empirical understanding of the impact of NBS based on hydrological, hydro-geomorphic, biogeochemical and ecological observations; b) Assess the water-related ecosystem services of a selection of NBS approaches on our landscapes and suggest ways in which the benefits can be enhanced; c) Assess the state of river corridors and their role in combating climate change, via ES impact indicator groups; d) Understand how to achieve transformative change via NBS that deliver multiple benefits and works across multiple sectors and scales..

For more information contact Mark Wilkinson: Mark.Wilkinson@hutton.ac.uk

TALK ABSTRACT Future Land Capability Assessment for Scotland

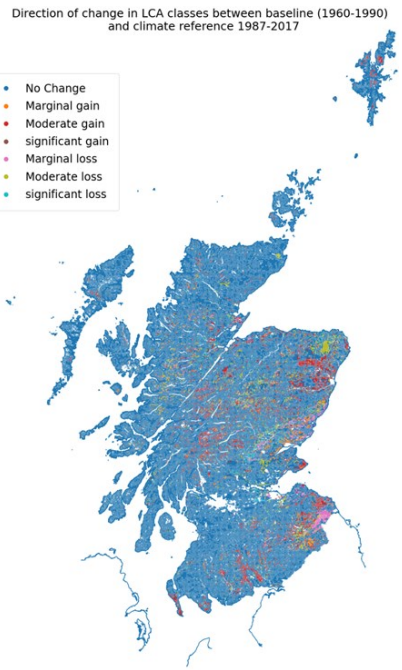
Emmanuel Udugbezi (The James Hutton Institute)

Increasing interest in the multiple benefits of land use (e.g., food production, ecosystem services, carbon sequestration etc) beyond just agriculture, demands understanding land capability in a changing climate. This understanding provides a strategic tool to inform land related net zero aims and climate change adaptation policies. Using a newly developed Land Capability for Scotland computing platform, we spatially estimated the values of the criteria determining the Land Capability for Agriculture (LCA) classes, using future climate projections (UKCP18). We identified risks and opportunities to land use options due to the impact of climate change.

Baseline estimates of LCA classes and criteria values were computed using soil series and 1-km gridded daily climate observation data (477,256 unique combinations) from 1960 – 2020 and future estimates (2020 – 2050) from 13 climate projections for the RCP 8.5 scenario. Results showed that climate change has already altered some LCA classes both positively and negatively.

Soil water balance modelling indicates that in the future reduced soil water availability is likely to have a significant impact on land use with potential risks to productivity.

For more information contact Emmanuel Udugbezi : Emmanuel.Udugbezi @hutton.ac.uk



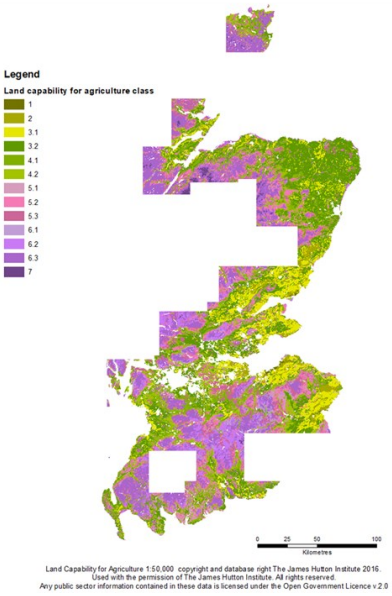
TALK ABSTRACT Understanding the value of Scotland's agricultural soil natural capital

Alistair McVittie (SRUC)

Soils are the main underpinning natural capital asset of Scotland's agricultural sector. They are not currently considered as a distinct asset in metrics such as the ONS Natural Capital Accounts or NatureScot's Natural Capital Asset Index.

A better understanding of the value provided by soils will contribute to monitoring the sustainability of Scotland's natural capital, indicate where policy intervention is required, and support land management decisions. This research takes a bottom-up approach to determine the main ecosystem services provided by Scotland's agricultural soils. This will evaluate the appropriate levels at which soil should be valued and monitored, i.e. as a distinct asset or part of wider system. This research responds to an identified gap through the valuation of a natural capital asset not currently directly captured in natural capital metrics.

For more information contact Alistair McVittie : Alistair.McVittie@sruc.ac.uk



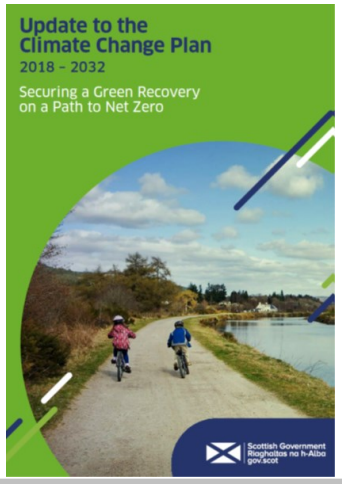
TALK ABSTRACT Soils and climate change; A Scottish perspective

Bob Rees (SRUC)

The Scottish Government has adopted ambitious policies to reduce greenhouse gas missions from agriculture and land use in which soil management will play a crucial role.

Policies include a recognition of the importance of reducing nitrous oxide emissions form fertiliser use, the expansion of soil testing and increasing soil carbon sequestration. This presentation will summarise the work being carried out in the Scottish Government's strategic research programme on greenhouse gas mitigation and carbon sequestration. Areas of planned future activity will also be discussed risks to productivity.

For more information contact Bob Rees: Bob.Rees@sruc.ac.uk



TALK ABSTRACT CentrePeat project

Rebekka Artz (The James Hutton Institute)

The CentrePeat project aims to inform the protection and restoration of peatlands across Scotland. In the first year of the 5-year programme we have made progress on jointly developing a draft methodology for a low-cost monitoring network for proxies of greenhouse gas exchange and condition of peatlands, initially with partners at James Hutton Institute, NatureScot and BioSS. We have explored the geospatial design of such a network and the potential methodologies that could be used. Alongside these developments, Hutton staff gathered and analysed data on carbon dioxide and methane emissions from the Scottish Greenhouse Gas flux network sites (SCO2FLUX) on peatlands. This network currently contains nine monitoring stations on peat, with a further four to be added soon. We have also expanded our monitoring capability for dissolved and particulate organic carbon (POC) lost via water courses at two of our monitoring sites, the data from which will feed into an ongoing evidence review of the emission factor for POC from peatlands. We are developing an integrated categorisation of peatland condition compatible with national scale peatland condition mapping and monitoring and link this to the development of Earth Observation-based indicators of water table dynamics as a proxy for emissions and a methodology to monitor restoration trajectories. In an effort to improve wider Natural Capital accounting, Hutton and SRUC partners in the project are working on an evidence-mapping review on ecosystem services and are beginning to explore a conceptual Marginal Abatement Cost Curve framework. A final piece of the programme is aiming to improve the ways we may be able to model the fate of peatland carbon and nitrogen cycling. In this talk, the progress made in our first year will be provided as a brief overview and links to outputs provided.

For more information contact Rebekka Artz: Rebekka.Artz:@hutton.ac.uk